A.D. 1865, *5th May.* N° 1263.

Brewing, &c.

LETTERS PATENT to Solomon Bennett, of Church Terrace, Lee, in the County of Kent, for the Invention of "IMPROVEMENTS IN BREWING, DISTILLATION, THE PRODUCTION OF VINEGAR, AND THE EXTRACT OF MALT AND OTHER GRAIN."

Sealed the 4th July 1865, and dated the 5th May 1865.

PROVISIONAL SPECIFICATION left by the said Solomon Bennett at the Office of the Commissioners of Patents, with his Petition, on the 5th May 1865.

I, SOLOMON BENNETT, of Church Terrace, Lee, in the County of Kent, do hereby declare the nature of the said Invention for "IMPROVEMENTS IN BREWING, DISTILLATION, THE PRODUCTION OF VINEGAR, AND THE EXTRACT OF MALT AND OTHER GRAIN," to be as follows :—

This Invention relates, firstly, to improvements in brewing by the preparation of the extract from malt. The malt is to be ground to meal or flour, and the sharps, pollards, and bran are to be separated therefrom, because they contain the excess of nitrogenous matter and oil, are more useful in the dry state for the purpose of feeding cattle or other purposes, and are not required in the extract. The ale is paler and of a golden hue, since the color which is derived from the shell of the malt is removed. There is a great economy in the process of boiling, the "worts" only requiring to be

boiled for about twenty minutes, in order to set any small remnant of nitrogenous matter, thus saving time and fuel. The bran, sharps, and pollard are of great value, being about 26 per cent. of the malt, which can be employed for cattle food in lieu of the "draff."

According to the practice hitherto in use the constituents of the malt as treated in the mash tun, are only partially converted into glucose by reason of the solubility of the diastase, its distance from the starch, and the protection of the husk, whereas by the grinding of the malt, and the removal of the husks, the affinity of the diastase for the starch in the process of mashing is rendered perfect, and the whole mass is converted into glucose, one mashing only being required. Therefore scarcely any nitrogenous matter or oil exists in the mash tun, as is at present the case, such nitrogenous matter or oil being only removed by the boiling in the ordinary process.

In brewing ale the meal is to be excited at a temperature of about 155° Fahrenheit, which must scarcely ever exceed 160°, in order to effect a partial conversion of the starch to cane sugar by eremacausis, or the action of diastase on the starch; by this process the yield of saccharine matter is increased in the "worts." It is then to be kneaded (after warming) with water termed "liquor," at a temperature of 165° Fahrenheit, or less, according to the quality of the goods, which I prefer to be done by a rotary process, similar to that employed in roasting coffee, as less heat is required; by this method the moisture in goods acts through the diastase of the malted goods, and causes a further conversion of the starch into cane sugar, and when well kneaded the liquor is to be added in any suitable mashing vessel.

A barrel of liquor being capable of holding in solution as glucose the meal of about two and a half quarters of malt, which quality can be afterwards reduced to such "lengths" as the brewer requires, according to the price of the extract, if care is exercised in not having the liquor at too high a temperature to cause the goods to set; the mash tun room is to be kept at an even temperature of 165 degrees, or thereabouts, in order to maintain an equal heat in the mash tuns to assist the action of the diastase. This equality of temperature may be effected by hot-water pipes or flues, or other means.

In brewing stout the meal is warmed at a temperature of about 155 degrees, or not exceeding 160 degrees Fahrenheit, as before, and to give colouring matter to the liquor I roast a portion of unmalted meal and mix it with the malted meal. The meal is then to be kneaded as before, and afterwards mashed. I agitate the contents of the mash tun by means of a series

of screw blades set horizontally on a vertical shaft in the centre of the mash tun, such shaft deriving rotating motion from a steam engine; these blades resemble screw propellers, and being close to the bottom of the mash tun, throw up the meal, and cause the complete conversion of the glucose by the action of the diastase upon the starch. The edges and surfaces of the blades are provided with feathers or projections, so as to increase the agitation of the liquor which is raised and thrown over in a series of eddies. The top of the mash tun is covered or enclosed in order to assist in maintaining the temperature, and to prevent the influence of the external air. The liquor may be drawn off when required by pipes at the side of the mash tun.

Three reasons can be assigned for this part of the process:—1st, there is a saving of fuel by the unnecessary process of reducing the "lengths," which by the present method is required for the exhaustion of the "goods." 2nd, the loss of saccharine matter in the boiling by its decomposition is avoided. 3rdly, there is no occasion to employ the "attemperator" to maintain the heat which the liquor loses by falling upon the cold "goods," and a dense "wort" is obtained, because the temperature of the mash tun room is itself maintained at the desired temperature.

The meal in mouth of the kneader is to be warmed to a temperature of 160 degrees, or thereabouts, by means of a feather passing through it over the mash tun, where the meal is over the tun. I prefer the meal to be crushed through steel fluted rollers, and raised into the chamber over the mash tun by an elevator after separation from draff by any of the well-known means.

After the goods are well mashed, I then boil in a copper by steam or other means for 20 minutes to set any remaining gluten, or its homologues (nitrogenous matter; or I may boil in the mash tun itself, as the goods are already dissolved. I then add a decoction obtained by boiling the hops, or by running the hot liquor on them, and filtering, and further by expression in any suitable method. The cake which results I break up and repeat it as often as desirable, according to the quality of the hops. I obtain by this means all the preservation of the hops, the lupuline and other properties; I then cool the wort, as is well known, to a proper "pitch" for the fermenting tuns, by a refrigerator or other means. I employ a driving screw or agitating feather in the fermenting square to promote perfect catalyois. The yeast from the tun is to be removed by a chain skimmer driven by a spur toothed pinion, preventing fret, yeast bite, ropiness, accelerating and also obviating the cleansing process, as such square can be used for the cleansing. A feather

for promoting the aforesaid object may also be employed in the cleansing tuns. To prevent the rise in temperature of the liquid, which would be great through the direct action of the spurs of the screw, I check the temperature by a refrigerator maintained at the initial temperature of about 70 degrees for fermentation.

In the improved method of distillation I also separate the flour or meal from the sharps, pollard, or bran. By such separation the liquor required to wet the "goods" is much less, the "wash" from it is not so great. The oil which causes so much trouble and annoyance will scarcely exist. And, as before stated in the process of brewing, there is great economy by the removal of the sharps, pollard, and bran, which are useless here by reason of their nitrogenous property, and are available in the dry state for forming food for cattle, or for other purposes. The meal is kneaded as before, or by any other suitable means after warming by any suitable process, which I prefer to be done by a process similar to that employed in roasting coffee; the temperature is not required to be so great, and will also much depend on the "flinty quality of the "grain" under treatment; but I prefer about 140 to 150 degrees Fahrenheit. By this method the moisture in the "goods" acts through the diastase of the malted goods, and (if, as I propose to do by this Invention, I employ unmalted meal free from bran, pollard, and sharps, in various proportions mixed with malted meal) also through the gluten of such raw meal to saccharize the starch, but I never allow the goods to lose their moisture; the time necessary will also depend upon the size of the warming or exciting apparatus which causes the conversion, as before stated. When the meal falls from the end of the apparatus I knead it with "liquor" at about 140 to 150 degrees, or at the temperature being lower, according to the excess of unmalted meal, and increase such temperature as required when kneaded. I continue the flow of liquor on the goods until they are quite exhausted and rendered entirely soluble, and if due care is exercised there will not remain any residue of the "grist;" the density of the wort will suit the pleasure of the brewer, and the "goods" need not be set if the temperature be not raised to high. The liquor is then to be subjected to fermentation; but I prefer to apply a feather, as before stated, without the skimmer, and with an attemperator, and afterwards to the process of distillation by the ordinary method in use. In the manufacture of vinegar I exhaust the meal from malt after the separation of the sharps, pollard, and bran, as before stated, and thus the nitrogenous matter and excess of oil which are the leading causes of putrefaction are removed. The meal is then to be treated

as in brewing, and reduced, after which it is fermented and acetified by any well known means.

SPECIFICATION in pursuance of the conditions of the Letters Patent, filed by the said Solomon Bennett in the Great Seal Patent Office on the 4th November 1865.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, SOLOMON BENNETT, of Church Terrace, Lee, in the County of Kent, send greeting.

WHEREAS Her most Excellent Majesty Queen Victoria, by Her Letters Patent, bearing date the Fifth day of May, in the year of our Lord One thousand eight hundred and sixty-five, in the twenty-eighth year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me, the said Solomon Bennett, Her special licence that I, the said Solomon Bennett, executors, administrators, and assigns, or such others as I, the said Solomon Bennett, executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an Invention for "IMPROVEMENTS IN BREWING, DISTILLATION, THE PRODUCTION OF VINEGAR, AND THE EXTRACT OF MALT," upon the condition (amongst others) that I, the said Solomon Bennett, executors or administrators, by an instrument in writing under my, or their, or one of their hands and seals, should particularly describe and ascertain the nature of the said Invention, and in what manner the same was to be performed, and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said Letters Patent.

NOW KNOW YE, that I, the said Solomon Bennett, do hereby declare the nature of my said Invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This Invention relates, firstly, to improvements in brewing by the preparation of the extract from malt. The malt is to be ground to meal or flour, and the sharps, pollards, and bran are to be separated therefrom because they contain the excess of nitrogenous matter and oil, and are more useful in the dry state for the purpose of feeding cattle or other purposes, and are not

required in the extract. The ale is paler and of a golden hue, since the color which is derived from the shell of the malt is removed. There is a great economy in the process of boiling, the "worts" only requiring to be boiled for about twenty minutes in order to set any small remnant of nitrogenous matter, thus saving time and fuel, The bran, sharps, and pollard are of great value, being about twenty-six per cent. of the malt, which can be employed for cattle food in lieu of the draft.

According to the practice hitherto in use the constituents of the malt, as treated in the mash tun, are only partially converted into glucose by reason of the solubility of the diastase, its distance from the starch, and the protection of the husk; whereas by the grinding of the malt, and the removal of the husks, the affinity of the diastase for the starch in the process of mashing is rendered perfect, and the whole mass is converted into glucose, one mashing only being required; therefore scarcely any nitrogenous matter or oil exists in the mash tun, as is at present the case, such nitrogenous matter and oil being only removed by the boiling in the ordinary process.

In brewing ale the meal is to be excited at a temperature of about 155° Fahrenheit, which must scarcely ever exceed 160°, in order to effect a partial conversion of the starch to cane sugar by eremacausis, or the action of diastase on the starch; by this process the yield of saccharine matter is increased in the "worts." It is then to be kneaded (after warming) with water termed "liquor," at a temperature of 165° Fahrenheit, or less, according to the quality of the goods, which I prefer to be done by a rotary process similar to that employed in roasting coffee, as less heat is required; by this method the moisture in goods acts through the diastase of the malted goods, and causes a further conversion of the starch into cane sugar, and when well kneaded, the liquor is to be added in any suitable mashing vessel.

A barrel of liquor being capable of holding in solution as glucose the meal of about two and a half quarters of malt, which quality can be afterwards reduced to such "lengths" as the brewer requires, according to the price of the extract, if care is exercised in not having the liquor at too high a temperature to cause the goods to set. The mash tun room is to be kept at an even temperature of 165 degrees or thereabouts, in order to maintain an equal heat in the mash tuns to assist the action of the diastase; this equality of temperature may be effected by hot-water pipes or flues, or other means.

In brewing stout, the meal is warmed at a temperature of about 155 degrees, or not exceeding 160 degrees Fahrenheit, as before, and to give coloring matter to the liquor I roast a portion of unmalted meal and mix it

with the malted meal; the meal is then to be kneaded as before, and afterwards mashed. I agitate the contents of the mash tun by means of a series of screw blades set horizontally on a vertical shaft in the centre of the mash tun, such shaft deriving rotating motion from a steam engine; these blades resemble screw propellers, and being close to the bottom of the mash tun, throw up the meal, and cause the complete conversion of the glucose by the action of the diastase upon the starch. The edges and surface of the blades are provided with feathers or projections so as to increase the agitation of the liquor, which is raised and thrown over in a series of eddies. The top of the mash tun is covered or enclosed in order to assist in maintaining the temperature and to prevent the influence of the external air. The liquor may be drawn off when required by pipes at the side of the mash tun.

Three reasons can be assigned for this part of the process:—1st, there is a saving of fuel by the unnecessary process of reducing the "lengths," which by the present method is required for the exhaustion of the goods; 2nd, the loss of saccharine matter in the boiling by its decomposition. 3rdly, there is no occasion to employ the "attemperator" to maintain the heat which the liquor loses by falling upon the cold "goods," and a dense "wort" is obtained, because the temperature of the mash tun room is itself maintained at the desired temperature.

The meal in mouth of the kneader is to be warmed to a temperature of 160 degrees, or thereabouts, by means of a feather passing through it over the mash tun when the meal is over the tun. I prefer the meal to be crushed through steel-fluted rollers, and raised into the chamber over the mash tun by an elevator after separation from draff by any of the well known means.

After the goods are well mashed, I then boil in a copper by steam or other meaus for 20 minutes to set any remaining gluten or its homologues (nitrogenous matter); or I may boil in mash tun itself as the goods are already dissolved. I then add a decoction obtained by boiling the hops, or running the hot liquor on them and filtering, and further by expression in any suitable method. The cake which results I break up, and repeat it as often as desirable according to the quality of the hops. I obtain by this means all the preservation of the hops, the lupuline, and other properties. I then cool the wort, as is well known, to a proper "pitch" for the fermenting tuns by a refrigerator or other means. I employ a driving screw or agitating feather in the fermenting square to promote perfect catalysis. The yeast from the tun is to be removed by a chain skimmer driven by a spur toothed pinion, preventing fret, yeast bite, ropiness, &c., accelerating and also obviating the

cleansing process, as such square can be used for the cleansing process, as such square can be used for the cleansing cleansing. A feather for promoting the aforesaid object may also be employed in the cleansing tuns. To prevent the rise in temperature of the liquid, which would be great through the direct action of the spurs of the screw, I check the temperature by a refrigerator maintained at the initial temperature of about 70 degrees for fermentation.

In the improved method of distillation I also separate the flour or meal from the sharps, pollards, or bran. By such separation the liquor required to wet the goods is much less, the "wash" from it is not so great. The oil which causes so much trouble and annoyance will scarcely exist. And as before stated in the process of brewing, there is great economy by the removal of the sharps, pollard, and bran, which are useless here by reason of their nitrogenous property, and are invaluable in the dry state for forming food for cattle or for other purposes. The meal is kneeded as before, or by any other suitable means, after warming by any suitable process, which I prefer to be done by a process similar to that employed in roasting coffee; the temperature is not required to be so great, and will also much depend on the "flinty" quality of the "grain" under treatment; but I prefer about 140 to 150 degrees Fahrenheit. By this method the moisture in the "goods" acts through the diastase of the malted goods, and (if, as I propose to do by this Invention, employ to unmalted meal free from bran, pollard, and sharps, in various proportions mixed with malted meal) also through the gluten of such raw meal to saccharize the starch, but I never allow the goods to lose their moisture; the time necessary will also depend upon the size of the warming or exciting apparatus which causes the conversion as before stated. When the meal falls from the end of the apparatus, I kneed it with liquor at about 140 to 150 degrees, or at the temperature previously used, the temperature being lower according to the excess of unmalted meal, and increase such temperature as required when kneaded. I continue the flow of liquor on the goods until they are quite exhausted and rendered entirely soluble, and if due care is exercised there will not remain any residue of the "grist;" the density of the wort will suit the pleasure of the brewer, and the "goods" need not be set if the temperature be not raised too high. The liquor is then to be subjected to fermentation, but I prefer to apply a feather, as before stated, without the skimmer, and with an attemperator, and afterwards to the process of distillation by the ordinary methods in use. In the manufacture of vinegar I exhaust the meal from malt after the separation of the sharps, pollard, and bran, as before stated, and thus the nitrogenous matter and excess of oil, which are the

leading causes of putrefaction, are removed. The meal is then to be treated as in brewing and reduced, after which it is fermented and acetified by any well known means. From the foregoing description the nature and objects of my Invention will be understood by those conversant with the art of brewing.

I proceed to give further details of the various processes aided by Drawings. I would, however, here remark that I am aware that in the Provisional Specification granted to Henry Dirks, dated November 7, 1856, No. 2619, it is stated that the malt or unmalted grain is ground, and that the flour and husk are treated separately in suitable vessels. It is also stated that the flour and husk so produced are applied to brewing, distillation, &c., that is to say, that the flour and husk are both made use of, although treated in separate vessels. It is also stated in the Final Specification that the bran or husk is operated on by itself, or mixed with the pollard, and that the mash tun is covered up for some time to saccharify the small adhering portion of starch, and to obtain the coloring and flavoring principles of the husk. It is also stated that coloring may be prepared from the husk roasted in rotatory cylinders. It is stated that worts may be obtained from the flour of malt to produce pale and mild or bitter beers, &c., but no process of working is described, neither is the object stated except in the sixth claim, where the object is to free the concentrated extracts from the coloring and bitter of the separated husk; and in the seventh claim it is stated that the pale extracts or worts are deprived of husk flavor in brewing either mild or bitter ale.

Now I have already specified that I make no use of the husk, pollard, or bran in the mash tuns, but that I prepare the wort from the flour of malt alone, and I describe the method of working in such manner that any practical brewer can operate my Invention. I have also stated the objects I have in view for separating and dispensing with the use of the husk, viz., on account of the excess of its nitrogenous properties, and for other reasons described; so also in the method of distillation and the production of vinegar I dispense with the husk, and use the meal of malt and unmalted grain.

Fig. 1 of the Drawings shews an elevation of the building of a brewery with the general arrangements suitable to my Invention. Figs. 2, 3, and 4 shew the parts in detail of my improved mashing apparatus Figs. 5 and 6 represent the fermenting squares.

Hereafter I shall proceed to describe these Figures respectively, and I will now describe some particulars necessary to be observed in the general method of operating according to my Invention.

In brewing pale ale I prefer to use flinty malt, and I also prefer that the liquor should on every occasion have been boiled to remove the temporary hardness and any organic matter, as well as to deoccygenate it before such liquor is employed for extraction. The malt is to be crushed between rollers in order to separate the meal from the shell, for if crushed too fine it would pass with the flour through the dresser owing to its dryness. It is then passed through a dressing machine, the air being carefully excluded throughout the process, the offal, bran, or husk being thus separated or removed. The meal alone is then raised from the dresser, which is encased in a warm tube of about 155° Fahrenheit to mellowing bin. The meal should be agitated in the mellowing bin chamber by means of arms placed on a suitable shaft and driven by machinery. The carbonic acid from the fermenting tuns which is removed by the skimmer is collected and pumped into the dressing chamber and raised by elevator to prevent oxygen of the air from acidifying the meal, the temperature being maintained on meal floor at about 160°

Malt when well dried contains about seven per cent. by weight of moisture, and such further addition before grinding, if ground by stones to separate the husk more successfully, as ground, and by this aid of heat, which is augmented by grinding through the diastase, converts a further portion of the starch C12H10O10, into dextrin isomeric in elements of composition with sucrose or cane sugar $C^{12}H^{11}O^{11}$, and progressively absorbing such liquor (water) HO and it remains to mellow, but I prefer the time never to be more than 24 hours; if moistened before grinding it would be unchanged or unacidified within four days, even after it had received such further addition before grinding and exposed to the influence of the atmosphere; but I do not recommend so long a period, but if it is charged and protected by carbonic acid it would remain a long time conserved.

I cause the meal to pass down a hopper into a small kneading apparatus over the mash tun, or into a mash tun consisting of a central shaft carrying two or more screw blades working close on to the bottom of the mash tun, the blades having projections thereon as hereafter described.

An air-tight double dish cover is accurately fitted, through which the shaft works; the under side of the dish cover is convex, and is perforated with fine holes. I much prefer that the meal should be passed through a small one, as it relieves the mash kneader, and can consequently be converted more rapidly as it undergoes a part of the process of augment of liquor HO for the composition and arrangement of the elements, but it can successfully be

dispensed with should proper care be given by the attendant. The meal passes on to the blades under a gentle charge of liquor HO of about 155 to 160° Fahrenheit, and is well kneaded, more meal and more liquor is added, the dough is raised from the toe of the screw and is macerated by the pins on the blades, and these being passed on by series after series to the heel of the blade, thus converting progressively the meal by the induction of water HO; it may thus run through the formula of composition, having the same carbon formula fructose or fruit sugar C12H12O12, undergoing gradual progressive changes by maceration sereatim by the diastase until it is converted by a further induction of liquor HO into glucose or grape sugar $C^{12}H^{14}O^{14}=C^{12}H^{12}O^{12}\ 2+HO$. This length can be reduced to any standard to suit the requirements of the brewer either before the boiling process or refrigeration, or after fermentation, but I prefer it to be increased after fermentation or during it.

The mash tun room is kept constantly at a temperature of about 170 degrees Fahrenheit by means of flues or hot-water pipes, and the liquor HO is supplied from the tank at about 160 degrees, consequently a great saving of heat is created; there is no radiation, no "setting" of the goods, no "balling," no acidifying, no reduction of lengths by evaporation. The wort is dense, there is very little "color" or "oil," no liquor is absorbed by the "draff," nor is expensive machinery required. The attemperator is dispensed with, and consequently its uncertainty and danger of employment avoided. The sparger is not required, and the extract is obtained at one mash by the catalytic action of the diastase on all sides in the meal, and being unprotected by shell, and the diastase not removed by the successive mashing as now in present operation. The wort is then to be tested by iodine to ascertain when the whole of the starch is converted into glucose by maceration; it will take, say, about 3 hours, but much depends upon the quality and quantity of the malt treated, the flinty quality requiring longer time, and the soil upon which the grain is grown and the result of the malting. I next proceed to obtain a clear wort. I boil by steam passing through the mash at the bottom in preference to a naked fire, which would burn the "grounds," and the screw being slowly worked at the same time. The diastase with nitrogenous matter is thus "killed" and coagulates, leaving a clean sound dense wort after it is precipitated to run into the underback, and thence to be pumped to the refrigerated, in which an agitator is worked, which method I prefer to using coolers, as there is no dissipation of vapour or fear of oxidation. I now prepare a decoction of hops, which is placed in an

inner perforated vessel, by gently simmering them in liquor over a naked fire at a temperature of about 180 degrees, the liquor having been previously boiled according to the quality of the hops and the quantity. Hot water or steam pipes may be employed in lieu of the fire, the temperature in each case being made for some time to acquire 212 degrees. The glucose or dense wart having been cooled to the proper pitch and run up to the lip of the skimmer, the barm charged with air, and afterwards air alone, is forced into the covered fermenting squares or rounds say at about 70 degrees, and the wort being dense there is no danger of its acidifying or becoming sour; the ferment will become very violent, which I check by refrigeration. I inject liquor that has been boiled into the square or round to maintain the loss of liquor required during the attenuation, at whatever heat the brewer prefers; and in order to expedite the process I employ two or more arms carrying feathers with fingers or studs set thereon, which assist in developing the yeast sporules, each of which bursting would overstore the tun (thus shortening the time required to attenuate); I then set in motion a chain skimmer, which removes the barm as quickly as it is germinated. The liquid which passes over the lip with the barm and carbonic acid C_2O_4 is separated and restored to the tun. Towards the close of fermentation I run a quantity of wort out, and add a decoction of hops (from hop back over the square or round,) which being an antiferment, in conjunction with the alcohol $C_4H_6O_2$ eliminated, combined with the exclusion of the oxygen of the atmosphere, retards the process of fermentation, as oxygen is necessary for the developement of the barm, obviating the cleansing, as the per-centage of alcohol will depend on the quantity of agency of its developement, or water HO and air. The gyle is thus cleansed in tun or run in suitable vessels and cleansed. It is then pumped to store vats, and there I increase the length by pumping liquor which has been boiled at a temperature which will most readily combine in union, say at about 70 to 75 degrees Fahrenheit, as at that point it more readily unites with the aldehyde $C_4H_4O_2$. In brewing stout and porter I follow the same process, but to give color I take the flour of barley and roast it by a rotatory process and proceed as in ales.

Fig. 1 represents, as before stated, a section of a building or brewery suitable for the purposes of this Invention. Many of the principal details are omitted, such as the engine and boiler and gearing, sundry pipes, &c., and many minor details which it is unnecessary to shew, as they are either well known, or may be readily comprehended from the general description. A, A, are the closed liquor backs at the top of the building to supply the various

tanks; these backs are heated by pipes *b* coming from the three-way cock *c*, and from the boiler situated on the basement floor *d*, in any convenient situation, in order that they may be alternately boiled. The pipe *f*, when the cock at *e* is closed, serves to bring the hot liquor to the mash tun F *g*. G is the malt loft; H, the milling floor used for grindstones in distilling; I, the dressing floor; J, the mill chamber in which the meal is allowed to mellow. This chamber should be kept at 160 degrees Fahrenheit. K, the hopper; L, the small kneader to partly knead the meal before it passes into the mash tun at E^1; F is the mash tun; M, the underback; N, the small liquor tank, supplied with liquor at 155 degrees to feed the kneader L; the floor being 170 degrees; O, the liquor tank, at 160 degrees, to feed the mash tun by the pipe G^3; the vertical shaft of the mash tun has a cam keyed thereon, in which a slot or course is cut to receive a lever set on a fulcrum in order to raise and lower a valve at each revolution, so as to permit of the entrance of liquor through the concave and convex roof or cover of the mash tun. By regulating the position of the cam upon the shaft the supply of liquor can be likewise regulated to any desired quantity. P is the hop back; Q, the refrigerator; the liquor is pumped from artesian wells, and being heated therein by the worm pipe, is carried up to the hot liquor back, so as to utilize the heat. R is the receptacle for boiled liquor to supply the fermenting squares, S, S; the liquor should be at a temperature of say 65 degrees. T is the receptacle for the yeast and carbonic acid, and U the racking division. V is the chimney stack close to a wall or partition. Each floor of the building is in communication with the shaft to receive the latent heat passing from the boilers. In order to create the necessary draught the stack should extend to some height above the roof of the building, and be formed with a proper batter. Dampers are to be applied to regulate the current of air to effect the perfect combustion. The floors should be fireproof, the wall boxes being closed by proper iron doors, so as not to interfere with the working of the driving shafts. The temperature is thus maintained on the floors at a constant degree, radiation and the attemperator being dispensed with, as they are not at present under sufficient control. In order to ensure a suitable hygrometic condition of the atmosphere under such elevated temperature, open vessels containing liquor are suitably placed, the evaporation from which will effect the object in view, and thus there will not be any injurious strain upon those employed. The meal for pale ale brewing is brought to the temperature of 155 degrees Fahrenheit, and mellows in the chamber J. The temperature of the floor is to be maintained at about 160 degrees. I pump the carbonic acid

evolved from the fermenting square free from yeast from the chamber T into the dresser, and also into the chamber J, in as dry a state as possible, preventing contact with the atmosphere. The malt contains a small amount, say about seven per cent. of moisture, but this varies according to the quality, the "flinty" having less than the soft. The "flinty" has also less diastase than the soft, taking a longer time to convert the fecula in the process to glucose. The synthetical conversion is by the induction of moisture at about 155 to 170° Fahrenheit gradually, through the medium of the diastase (assisted by the carbonic acid gas, but it is not necessary). It is macerated into a stiff paste by my improved machine at once, or by a smaller one placed over the mashing tun; it consists of a shell or case F (Fig. 3, which is an elevation, and Fig. 4, which is a section), in which a two-bladed screw H is driven by a shaft G having flat pins or vertical projections H^4 (see also Fig. 2, which is a plan view of the blade and pins); the pins are set in radial rows on the system shewn. A dish cover F^1 is shewn, through which in a gudgeon gland G^1 the shaft G works, being turned by mitre-wheel gearing from the engine; the bottom of the shaft is supported in a shoe G^2. The under side of cover is formed of a dish F^2, Fig. 4, having a rose or series of perforations as shewn, fed by a pipe F^6 in the manner before described from boiled liquor back to liquor back on second floor at a temperature of about 160 degrees Fahrenheit, and at each revolution of the shaft a valve is raised by a pin working in the cam course on shaft G. The knead passes through a sleeve or opening E into the tun, the toe H of the screw blade throughs it plow like over from toe to heel H^3, whereby it is met by the projections H^4 traversing the moss at different levels and angles commingling and macerating it. To illustrate the results of this process I annex the following formula of composition :—

Anbydrous starch dextrin - - -	$C_{12}H_{10}O_{10}$
Cane sugar, or sucrose and gum - -	$C_{12}H_{11}O_{11}$
Anbydrous grape or fruit sugar fructose -	$C_{12}H_{12}O_{12}$
Grape sugar, hydrate starch sugar or glucose -	$C_{12}H_{12}O_{12}+2HO=C_{12}H_{14}O_{14}$.

The diastase effecting the union of water HO, termed liquor, with the fecula until converted by maceration into glucose $C_{12}H_{12}O_{12}+2HO=C_{12}H_{14}O_{14}$. The carbon formula of composition remains the same, although each successive change creates an increase of the atoms water in composition (HO). The diastase acting with its catalytic power upon all sides of the starch and gum, and is not confined, as it is by the processes hitherto used, and is compelled to do its work. So also the liquor not having to saturate and percolate

through any shell cannot take up any foreign mineral or earthy matter to deteriorate the gyle. The goods being treated at a temperature of about 155 degrees Fahrenheit, never exceeding 165 degrees, and the liquor to supply the mash to kneed and macerate at the same temperature gradually, does not allow the heat to increase sufficiently to kill the diastase, that is, to "set" it. The degree of heat is thus maintained at such an initial temperature to suit the goods, but never exceeding, until after conversion into glucose 170 degrees, either by the elimination of heat arising in the maceration from the conversion of goods. The glucose is then to be boiled either in the mash tun or run into the underback, or boiled with the decoction of hops, which, in either case I prefer to be done by steam taken from a boiler passing through the three-way cock F^6 (Fig. 3) and through the cock F^8, the chamber having a safety valve and guage F^4. The boiling continues for about 20 minutes. The remaining nitrogenous and albuminous matter coagulates, and a clear wort is obtained; after the ebullition has subsided the coagulum precipitates and the upper tap F^9 is set, and thus the wort runs to the underback. The pump driven by the shaft, pumps the wort into the refrigerator, which is a reverse of an ordinary still, and the liquor from the well passes through the spiral tube, removing the caloric, and thence into one of the liquor backs (which are alternately boiled by steam. When the worts are cooled down to about 65 degrees Fahrenheit they are passed through a pipe into the improved fermenting squares hereafter described. F^{10} is a man-hole for entrance to the mash tun; F^5 is a level guage. The bottom of the mash tun is provided with a moveable plate P, having its under surface double wedge-shaped, and closing the bottom of the tun and resting on two sliding blocks Q, Q, actuated by the right and left handed screw and wheel R. The object of this arrangement is when the screw is reversed to discharge the grounds precipitated, or if the crushed malt as is now employed can be all discharged without manuel labor, to throw them out.

Figs. 5 and 6 represent my improved fermenting squares. Fig. 5 being an elevation partly in section, and Fig. 6 a side view partly in section, similar letters denote corresponding parts. The square receives the worts through the pipe *s*, and when filled (or if worked without being entirely filled, are fitted with diaphragms or air cushions, and as filled, exhausted yeast and air are then forced into the square by the pipe V, and the shafts M are driven by the fast pullies M^3, loose pullies being also placed on the shafts; arms M^1, with fingers M^2, excite the developement of the yeast sporules, which, bursting and circulating over the area of the square, develop the alcohol in the gyle, the

barm and carbonic acid being removed by a chain skimmer P passing from end to end over the rigger O. N is the driving shaft, which is furnished with suitable drawing pins O^1 to work the chain or band to which the buckets or skimmers P^1 extending from side to side are attached. These remove the yeast and carbonic acid as quickly as it rises to the surface, which passes down the chamber R into the yeast tun. I propose to work the square at about 70 degrees, but the wort is cooled to about 65 degrees, which will increase during the conversion, but which degree is maintained by cold liquor being pumped through, and thence to liquor backs. To keep the liquor up to the lip of buckets P^1, liquor which has been boiled is supplied, and the fermentation will require the admission of air to aid the growth of the sporules. There is no danger of acetous fermentation taking place, as the density of the gyle is against it, neither will the wort become too attenuated, as the alcohol will check the fermentation, and retain sufficient saccharine body with the extractive coloring matter from the carbonized goods. To close the fermentation I run into the square sufficient decoction of hops, which is slightly an antiferment, and the conservative condition of the hops combined with the alcohol sufficiently cleanses the gyle, and checks further fermentation. The density of gyle is then to be reduced by the addition of boiled liquor from back to suit the price of goods to be supplied to consumer. T, T^2, shew an arrangement of pipes to be used as an attemperator. U shews the situation of a thermometer. The rounds for fermentation differ from the squares, but I employ the same method of charging as described for square, but modified as to detail by having a float to remove the yeast as developed, which passes down the hollow shaft; this shaft carries the pins and feathers.

The next part of my Invention relates to improvements in distillation.

In carrying out this part of my Invention I employ grain (only modified to the amount of raw grain used in the grist of the distiller in proportion to the malt); the degree of heat I prefer to be within 140 degrees to 150 degrees if the raw meal is in the proportion of about 3 to 1 of malt. I prefer in all operations to use water that has been boiled. I gently sprinke the grain before grinding, and I pass the grain through stones, as is well understood, and dress or separate the meal from the offal immediately after being ground, the meal alone being used, the offal made use of for other purposes. The atmosphere is at all times to be excluded; the dressing of the meal and its separation is to be performed in dresser, wherein the temperature is 140 to 150 degrees Fahrenheit. The meal is excited in a rotatory manner, or by an arm having pins or projections thereon; a portion of starch receives an addition of moisture and becomes

mellowed, that is, an increase of sugar in the meal, some of the starch being converted into cane sugar by the gluten of unmalted meal in the same manner and through the same agency as by the diastase in malted meal, but at a lower temperature and in a longer time. I then cause the meal to pass into another vessel through a hopper, where a stiff knead is made. I prefer in this operation that the atmospheric air should be excluded in order to prevent it becoming sour through the addition of moisture which it has received. The goods and chamber being of an initial and maintained temperature heated by flues or any well known means then being left to rest. I again moisten with liquor at about 140 to 150 degrees; the reaction of the diastase upon the gluten by its close proximity and intimate union allows of its full exertion in every direction, whilst by reason of the absence of the bran or offal all retardation in the conversion is prevented, the offal having been previously separated and removed, thus the oil and excess of nitrogenous particles with mineral and earthy matter do not enter into the wort. I continue the flow of liquor on the goods and macerate until they are rendered perfectly soluble. The reason of the mass becoming agglutinized is owing to the temperature of the liquor being too high, and the diastase with gluten being thus neutralized or destroyed the goods become set, hence the jelly-like appearance assumed by the mashing instead of its being converted into saccharine matter or glucose. The wort is then pumped into a refrigerator and thence into the fermenting tun to prevent it from undergoing the acetous fermentation; this must be done as quickly as possible, and the yeast is to be worked into the wort, and liquor which has been boiled is then to be run in by any suitable means to cause conversion under the influence of the ferment into its lowest point of attenuation, and immediately run into a still in order to separate the alcohol from the wort. By this process a purer spirit is obtained than from fecula wherein the offal is included, the spirit being free from potatoe oil faints, and there being less wash, producing a much greater yield of alcohol from the consequence of the goods being more thoroughly converted. Subjected to fermentation it should commence with a dense wort, and liquor which has been boiled run into it to commingle with the alcohol as generated, the temperature is thus maintained according to the wish of the brewer, and the lowest attenuation is attainable, having less saccharine in the wort; the yeast is not removed from it, but is seperated by distillation, as is well understood.

In reference to the manufacture of vinegar I employ the same method of separation and removal of the offal from the fecula, making use of the meal alone which is to be kneaded and macerated as before described, so that

after boiling the foreign substances shall be coagulated. The wort is converted and fermented as described in the previous process, and acidified by any well known means.

Having now described the nature of my said Invention, and the manner in which the same is to be performed, I would remark that I do not restrict myself to the exact details and configuration of apparatus which I have expressed and shewn, as they may be varied or modified when requisite without departing from the principles on which my Invention is based; but what I claim and desire to be secured to me by the herein in part recited Letters Patent are,—

1stly, the improved method of producing the extract of malt from the meal alone of malted grain by separating and removing the husk or offal therefrom, as and for the purposes described.

2ndly, the improved method or process of treatment of such extract, that is to say, the synthetical treatment of the meal by a gradual process after its separation until its entire conversion into one wort, and the principle of exhausting the goods by gradual or progressive reduction of liquor for conversion in one gyle, by never allowing the soluable diastase to be removed or killed until the complete solvency of the goods is effected by the immediate or intimate union or contact of diastase, and the action of catalysis in mashing.

3rdly, the keeping of the process as much as possible from the influence of oxidation, and maintaining each process at one uniform or initial temperature, for such processes the temperature of the mash tun room and respective floors being likewise regulated and maintained as herein described.

4thly, the improved construction of covered mash tuns with rose or perforated under cover, the arrangements for the supply of liquor, and the screw blade with projections or pins thereon for kneading or commingling the goods and other improvements as specified.

5thly, the general improvements in the fermenting square and rounds, substantially as specified.

6thly, the method and process of reducing the lengths of the fermentation, as herein specified.

7thly, the improvements in distillation by the employment of the meal alone and the process applicable thereto.

8thly, the improved method of producing vinegar by using the meat alone as described.

9thly, I also claim the application of my improved mash tun to mash

malted grain as hitherto used by brewers, the husk or offal not being removed.

And, lastly, the general arrangement of apparatus and system of operation in order to carry out the purposes of my Invention, substantially as herein shewn and specified.

In witness whereof, I, the said Solomon Bennett, have hereunto set my hand and seal, this Fourth day of November, in the year of our Lord One thousand eight hundred and sixty-five.

SOLOMON BENNETT. (L.S.)

Witness,

ALEX. PRINCE,

Office for Patents,

4, Trafalgar Square,

Charing Cross.

LONDON:

Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,

Printers to the Queen's most Excellent Majesty. 1865.